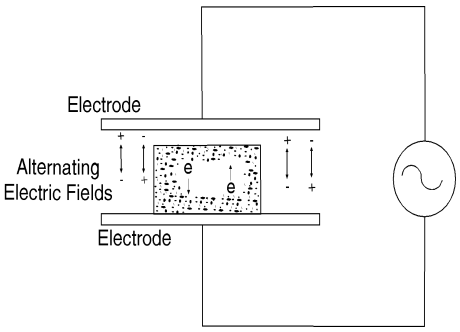
Applied Technology: Radio Frequency (RF)



Concept

Radio frequency (RF) electromagnetic waves cover the frequency spectrum from 30 to 300 MHz and, like microwaves, can be absorbed and converted to heat in nonmetallic materials known as "lossy dielectrics". For this reason, both RF and microwave heating are known as "dielectric heating". The two technologies can affect materials differently and require different equipment. RF energy mainly acts through the electrical conductivity of the material, so the presence of ionic species (e.g., dissolved salts) tends to make materials good heating candidates. RF generally heats more uniformly than microwave. RF energy is less expensive per kilowatt than microwaves; RF generator capacities range from a kilowatt to hundreds of kilowatts. RF heating has been used for commercial applications since World War II.

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Applications

- Curing wood adhesives and glass fiber coatings
- Drying wood, textiles and paper adhesives
- Moisture leveling
- Welding plastics
- Fluid treatment: boilers, cooling towers, water systems, machining fluids, waste lagoons
- Preheating plastics
- Post-baking food
- Plasma etching and vapor deposition for semiconductors

Technologies Replaced

- Gas fired drying, curing, and preheating ovens
- Wet-chemical etching
- Use of organic solvent-based adhesives

Wastes Reduced

- Combustion Products: COx, SOx, NOx, ROG, and particulates
- Off-spec moisture profile product waste
- Solvent-based adhesive VOCs
- Wet-chemical etch hazardous chemicals
- Water and coolant treatment chemicals

Potential in Manufacturing

Indust	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*	*Indust*	*SIC*	*Pot*
Food	20	MED	Lumber	24	MED	Chem	28	LOW	Stone	32	LOW	**Elect**	**36**	**HI**
Tobac	21	MED	Furn	25	MED	Petrol	29	LOW	Pmetal	33	LOW	Transp	37	LOW
Textile	**22**	**HI**	Paper	26	MED	**Rubber**	**30**	**HI**	**MetFab**	**34**	**HI**	Instr	38	LOW
Apparel	23	LOW	Printing	27	LOW	Leather	31	LOW	**Mach**	**35**	**HI**	Misc	39	LOW

Credits: **: Dr. Philip Schmidt and Dr. F.T. Sparrow;
Unimar Group, Ltd; The Electrification Council; Electric Power Research Institute**

Radio Frequency (RF) ***continued***

Technology Advantages

- Fast uniform heating
- Some tolerance of complex shapes
- Levels moisture while drying
- Enhances use of water based coatings and adhesives
- Fast startup/shutdown
- Precise control (can be computerized)
- Compact equipment
- High throughput rate
- Low emissions
- High energy efficiency

Technology Disadvantages

- Not inherently self-regulating; product can overheat
- Can arc in high humidity or low pressure
- Convection systems more tolerant of complex shapes
- Effectiveness dependent on product dielectric characteristics
- High capital cost
- Requires specialized technical support
- Must be shielded (FCC regs)

Typical Costs

Capital Costs	O & M Costs	Potential Payback
$1.5k - $3k/kw depending on size and application	Energy costs low due to high efficiency and elimination of large fan loads associated with combustion-fired ovens. Higher maintenance cost for specialized technical support.	About 1 year or more depending on application

Installations

Case A - Over 300 RF textile yarn drying units have been installed in plants in Europe, Taiwan and the U.S. Typical reduction in energy consumption per unit of product is 50-65%. Since this is all electric energy, on-site combustion emissions are eliminated. Because of the high efficiency of RF-based drying, net emissions, including the powerplant, are actually lower than those associated with conventional drying. The RF units achieve 70-120% increase in product throughput in the same space, and require about half the operating labor of conventional dryers..

Case B - A major wood products corporation installed a 300 kW RF redryer in one of its plywood plants for production of softwood veneer. Due to wide variations in the moisture content of wood, about 15% of the veneer exiting from the main steam-heated dryer is typically above the target moisture level and has to be redried. Conventional redrying, by recycling the veneer through the main dryer, results in scrap losses of 10 to 25% (1.5-5% of total production) due to uneven moisture profiling, with associated splitting, warping and cracking. With the RF redryer, scrap losses have been substantially reduced and productivity of the primary dryer has been increased by 15-20%. Payback period on the RF installation was estimated at 1.5 years.

Major Vendors

Radio Frequency (RF)

Cober Electronics, Inc
151 Woodward Avenue
South Norwalk, CT 06854
(203) 855-8755

Microdry
7450 Highway 329
Crestwood, KY 40014
(502) 241-8933

Nemeth Engineering Associates
5901 W. Highway 22
Crestwood, KY 40014
(502) 241-1502

PIAT, Inc.
(water and fluid treatment)
75 Eastern Steel Road
Milford, CT 06460
(203) 876-9570

Strayfield
Green Hills Corporate Center
2675 Morgantown Road, Suite 1405
Reading, PA 19607
(610) 856-5760

PSC, Inc.
21761 Tungsten Road
Cleveland, OH 44117
(216) 531-3375

Radio Frequency Company
150 Dover Road
Millis, MA 02054
(617) 762-4900

Thermex/Thermatron, Inc
60 Spence Street
Bayshore, NY 11706
(516) 231-7800

This list of vendors of the indicated technology is not meant to be a complete or comprehensive listing. Mention of any product, process, service, or vendor in this publication is solely for educational purposes and should not be regarded as an endorsement by the authors or publishers.

Index to EPRI DOCUMENTS

Radio Frequency (RF)

Electroforming, EPRI CMF TechCommentary, Vol 3, No 5, 1986

Radio Frequency Heating of Plastics, EPRI CMF TechCommentary, Vol 4, No 2, 1987

RF Curing of Furniture Adhesives, EPRI CMF TechApplication, Vol 5, No 1, 1991

RF Drying of Textiles, EPRI PIO TechApplication, Vol 2, No 2, 1990

Radio Frequency Drying of Dyed Yarns, EPRI TechApplication, TA-107023, 1996

[SEE ALSO MICROWAVE]

This information is designed to help you determine **potential** applications for the technology. You are encouraged to contact one of the listed vendors or a consultant for details and pricing.

This manual is not intended as a recommendation of any particular technology, process, or method. Mention of trade names, vendors, or commercial products do not constitute endorsement or recommendation for use. It is offered for educational and informational purposes and is advisory only.

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